High Altitude Ballooning and
The Effects of Temperature on Balloon Ascent Rate

Christopher Young
Advisors: Associate Professors Sherry McCormack and Scott Bain

• Abstract

High-altitude balloons are unmanned balloons, usually filled with helium or hydrogen, that after release, ascend into the stratosphere, generally attaining an altitude of between 60,000 to 100,000 feet. The balloon payload includes scientific experiments on organisms, equipment to study radiation, temperature, ultra- violet radiation, and pressure. The balloon flights and experiments are logged by means of video devices and are tracked from the ground through multiple tracking devices. The effect of temperature on the ascent rate of the balloon could change how the balloon expands as it ascends, affecting the burst height. The data collected from multiple different sensors will be altitude, time, and temperature. Once all of the data is collected, the ascent rate will be calculated, then a graph of ascent rate vs temperature will be made. With the graph being complete, the ascent rate will be compared to different temperatures to see if there is a correlation.

• Introduction

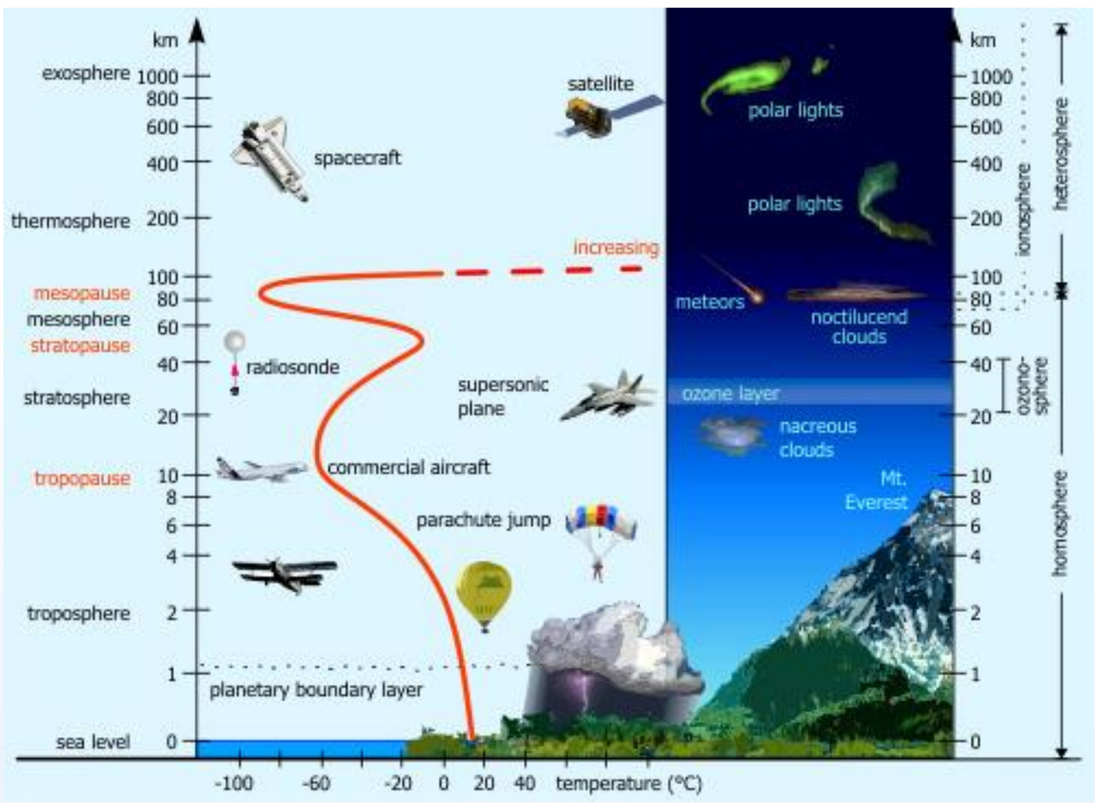
High-altitude ballooning (HAB) is student led research in which experiments weighing up to a few pounds are carried into the stratosphere. Students get to experience building and flying actual hardware that reaches near-space. HAB involves using latex weather balloons filled with helium containing a variety of experiments, to altitudes of 80,000 - 100,000 feet above sea level where the environmental conditions are much like those in Low-Earth orbit. Balloon launches to near-space parallel many of the challenges of an actual outer-space flight, but at a fraction of the cost.
These challenges include:

- surviving the mechanical rigors of the flight such as potential jet stream turbulence on ascent, fall-induced turbulence during the descent, and a parachute landing
- operating successfully in the harsh conditions of near-space including low pressure, low temperature, and high cosmic radiation levels
- tracking the flight using GPS-enabled radio systems
- recovering the payloads safely from all sorts of terrain, including trees, tall crops, and open water
- analyzing the experimental data, most of which is logged on-board rather than being transmitted to the ground during the flight

• Intro cont.

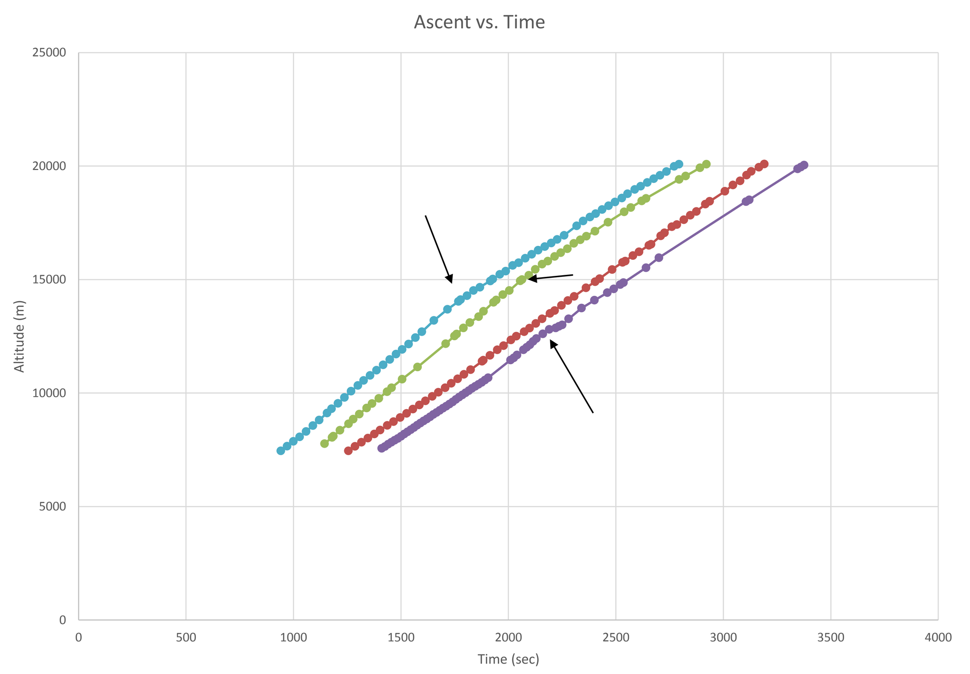
In recent balloon flights conducted by the Hopkinsville Community College Balloon Satellite program and data gathered from teams across the country, an anomaly was found in the ascent rate and trajectory of the balloons' path. Uncharacteristic changes in ascent rates have been observed near the tropopause on recent flights. Simple models indicate that ascent speed should be essentially constant with altitude. However, near the tropopause a virtually instantaneous reduction in ascent rate has been observed.

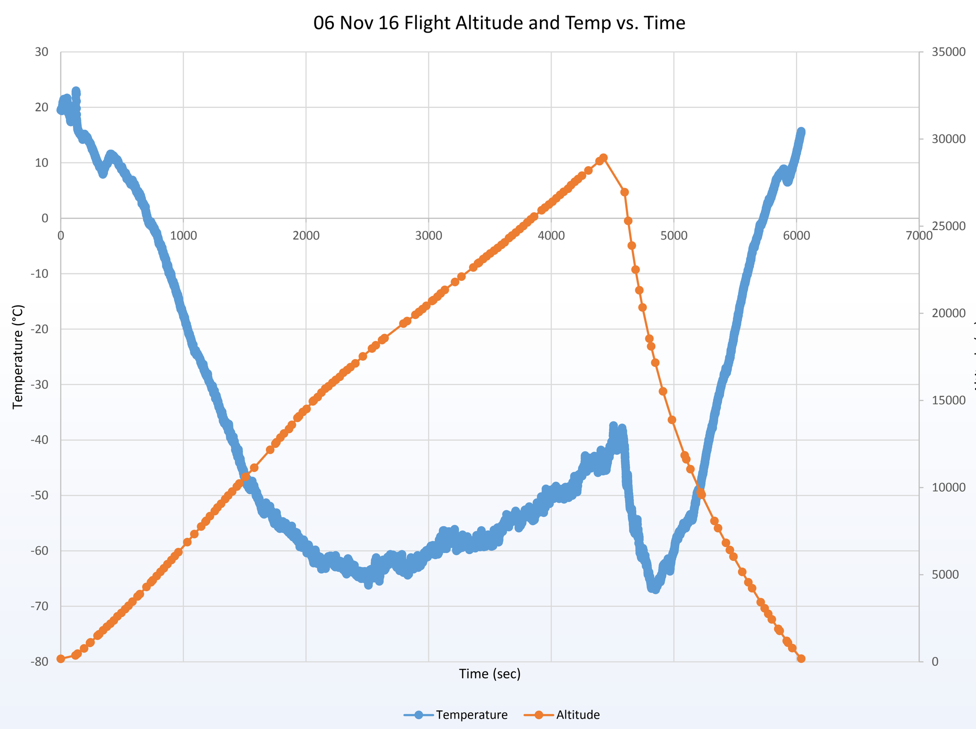
• Materials & Methods



The balloons ascend through the Tropopause then into the Stratosphere. The Tropopause is the area between the Troposphere and the Stratosphere. The Troposphere starts about 6km and continues until about 12km, with temperatures ranging from 62°F to -60°F. The Tropopause is the boundary separating the lower layer of the atmosphere (troposphere). The altitude of the tropopause varies according to sea-surface temperature and season, but also over shorter periods, from an average of 10–12 km over the North and South poles to 17 km over the equator. In the Tropopause is where the unusual bends in the data lines showed up.
This launch had new equipment that was being tested to use for the Solar eclipse in August 2017. There was a ground station that sent and received GPS, live video, and still images from different equipment on the balloons' payload.

• Results





As seen in the graphs, there was a slight change in the ascent rate in only a few on the flights. It did not happen to every flight. When it does show up, it is at the same general altitude. The second graph with temperature, shows the extreme change in temperature as the elevation changes. After looking at balloon launches from across the country, at different times of the year, the change in ascent rate shows up sporadically. Even though there is such an extreme change in temperature, it does not seem to effect the ascent rate of the balloon.

• Results cont.

The new equipment had some bugs. These bugs caused the results of the live video and still image cameras to not send clear images. The sensors were able to get very useful data. Many of the other experiments were able to acquire useful data.

• Conclusion

The effects of temperature on the ascent rates of high altitude balloons was inconclusive. Even there were extreme changes in temperature as the balloon reached the Stratosphere, it did not seem to change the ascent rate. However, an anomaly was found in the data that showed the ascent rate changing on average at the same altitude. This uncharacteristic change is being investigated further to determine it cause.

• Acknowledgements

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